

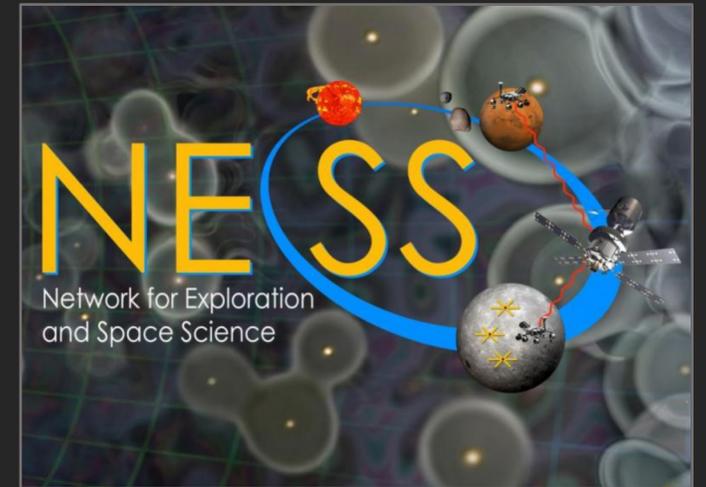


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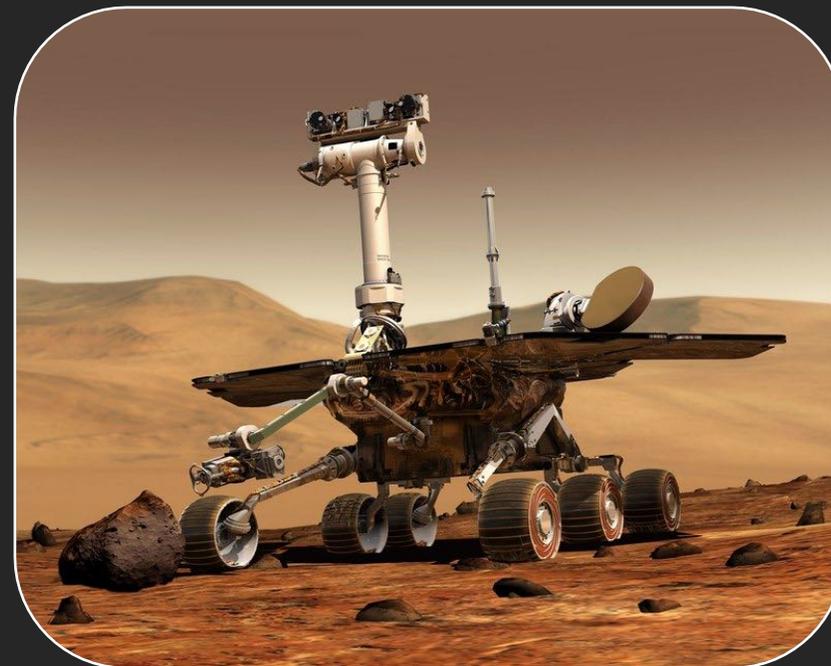
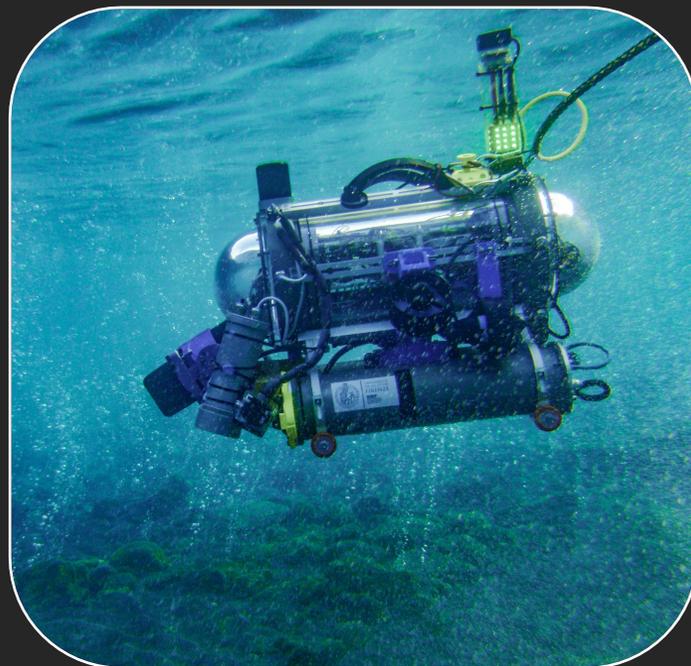
Virtual Reality Interfaces for Surface Telerobotics



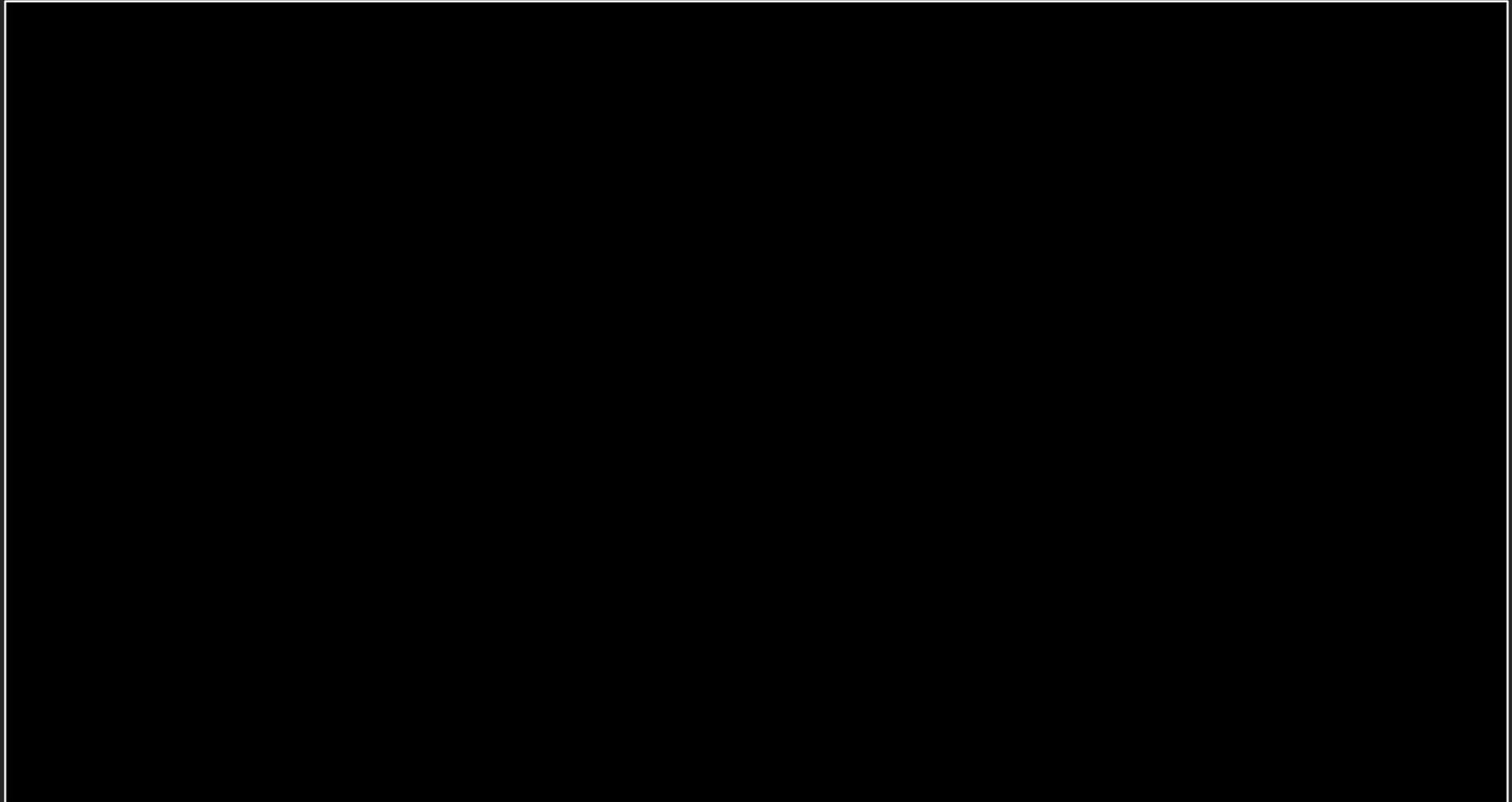
Michael Walker, Jack Burns, Daniel Szafir, and Ashwin Vasani

CU Boulder NESS Team & Interactive Robotics and Novel Technologies Laboratory

The Field of Telerobotics



Robotic Advancements: Hardware



Robotic Advancements: Software



Robotic Advancements: Interfaces?

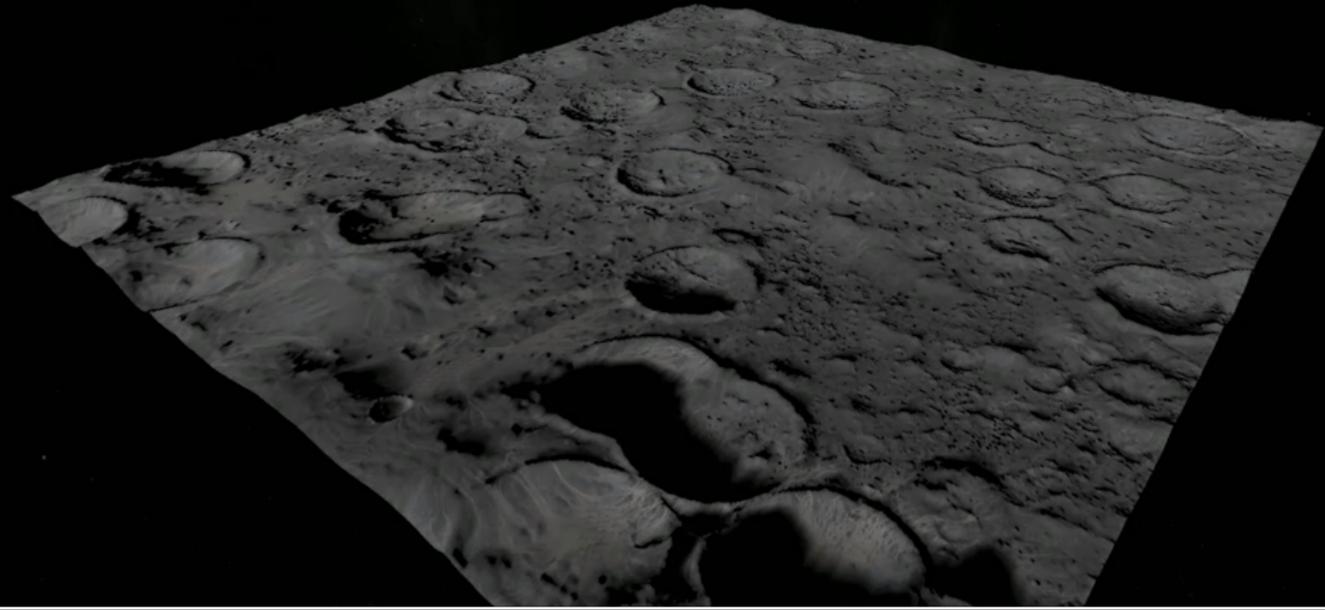


Virtual Reality Headsets

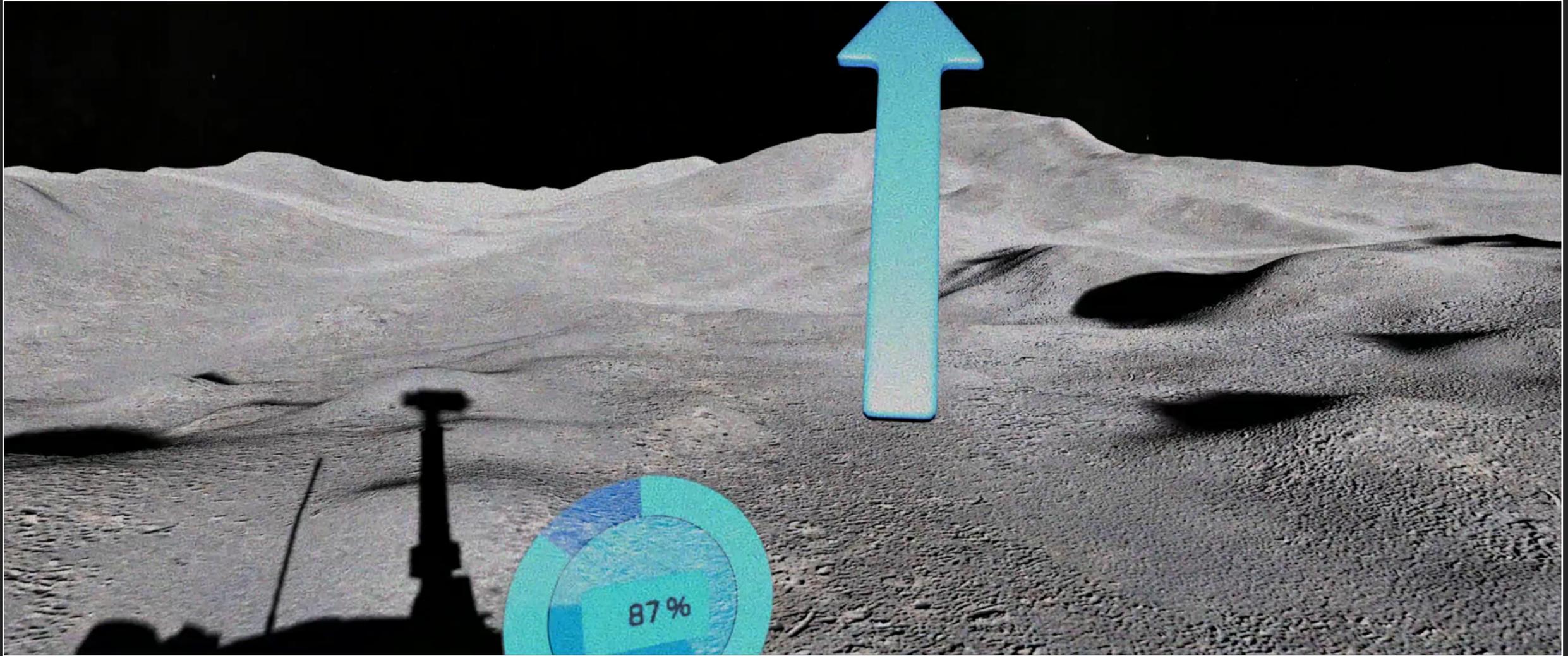


VR Headsets and Robots









Interface Experiment: Traditional vs. VR



Experiment: Design

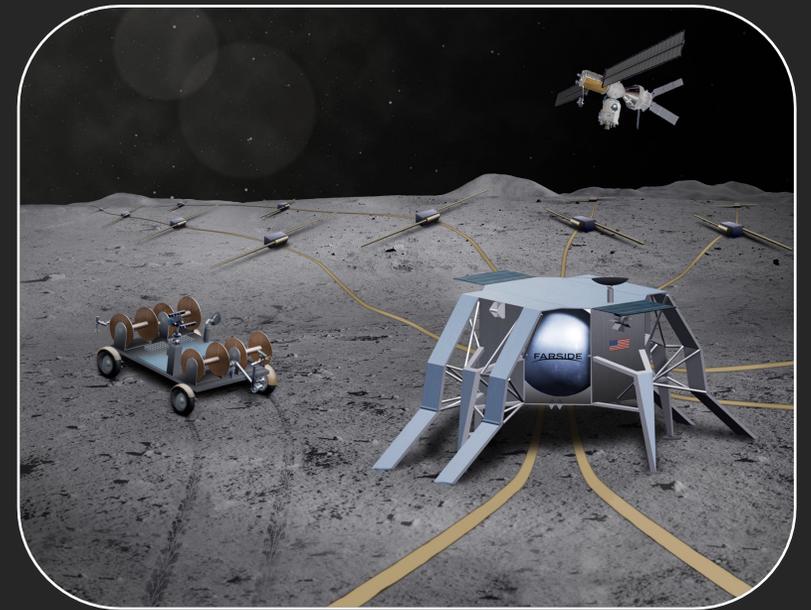
2 x 1 (Standard Interface or VR Interface)

Within-Subjects Design

12 Subjects

Gender: 10 Male & 2 Female

Average Age = 22



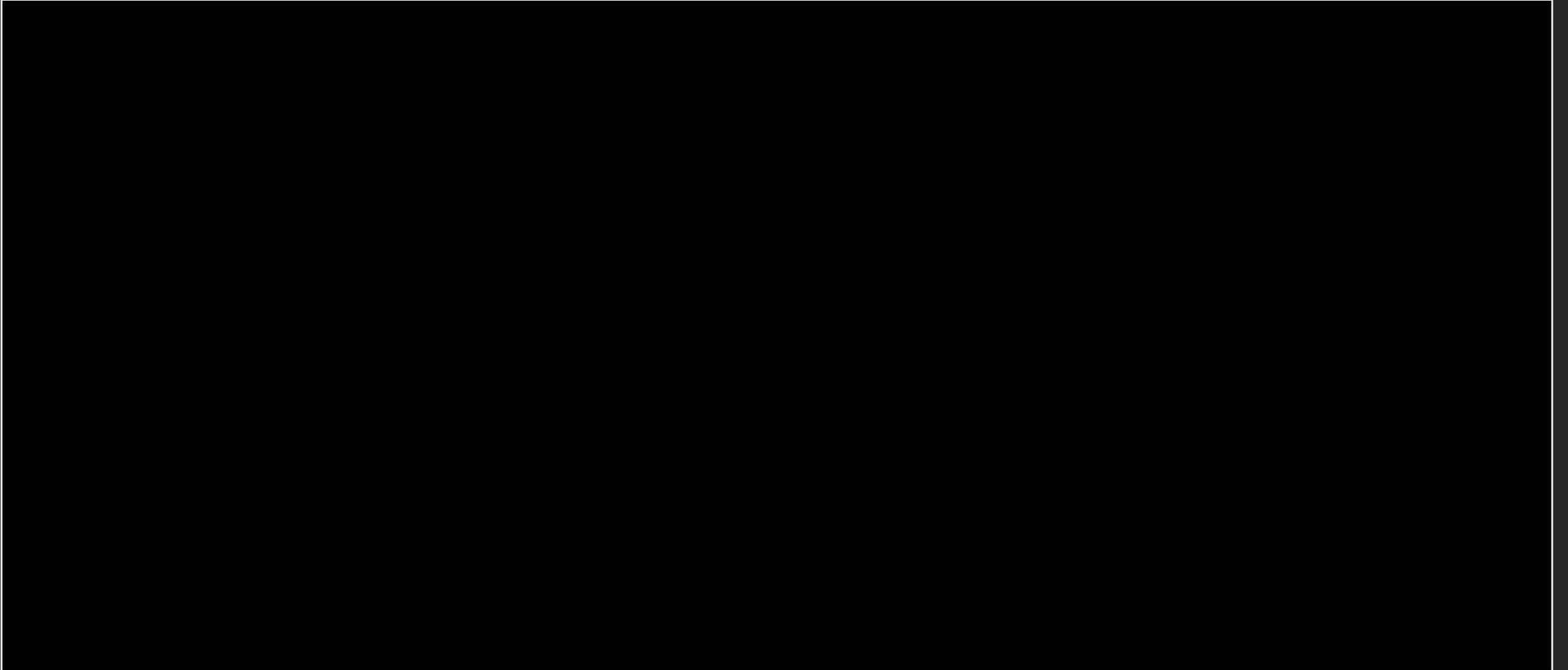
Evaluated over a series of robot teleoperation assembly tasks

Experiment: Apparatus & Environment

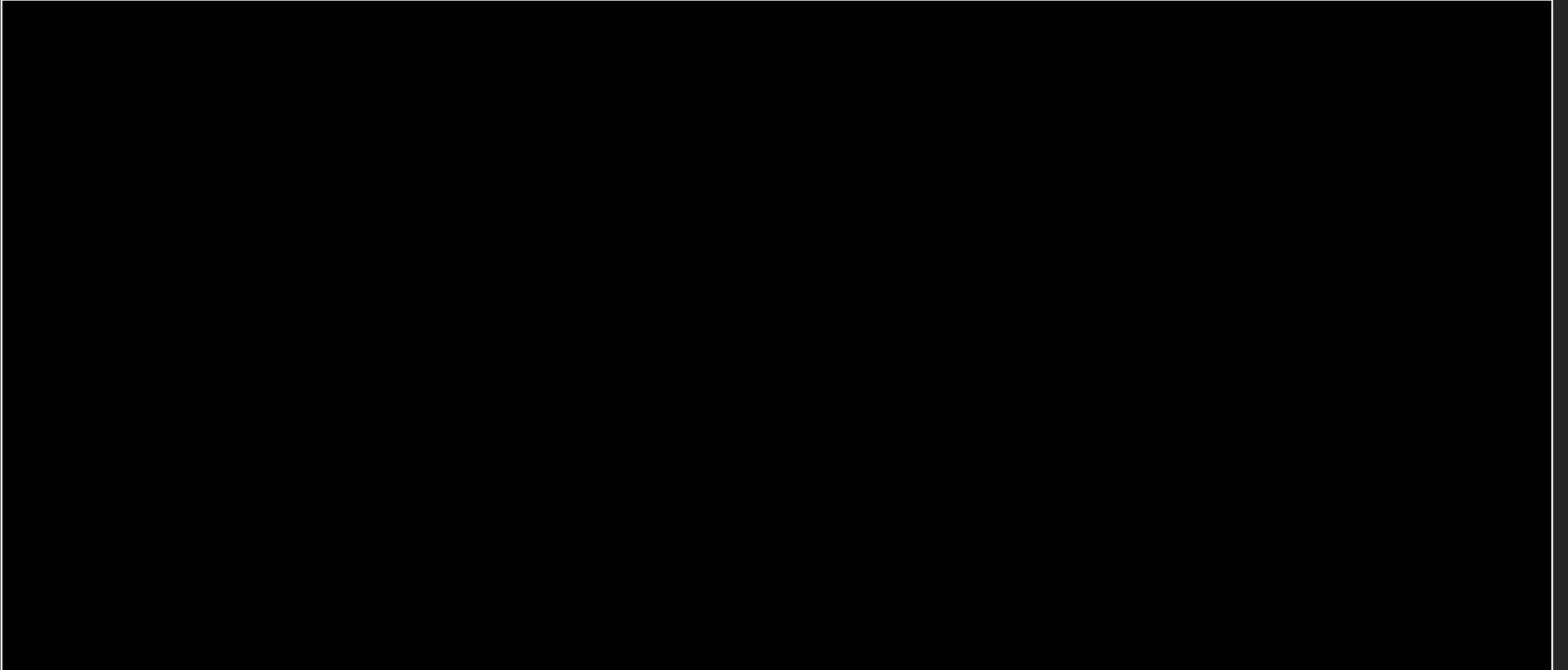




Experiment Task: Object Stacking

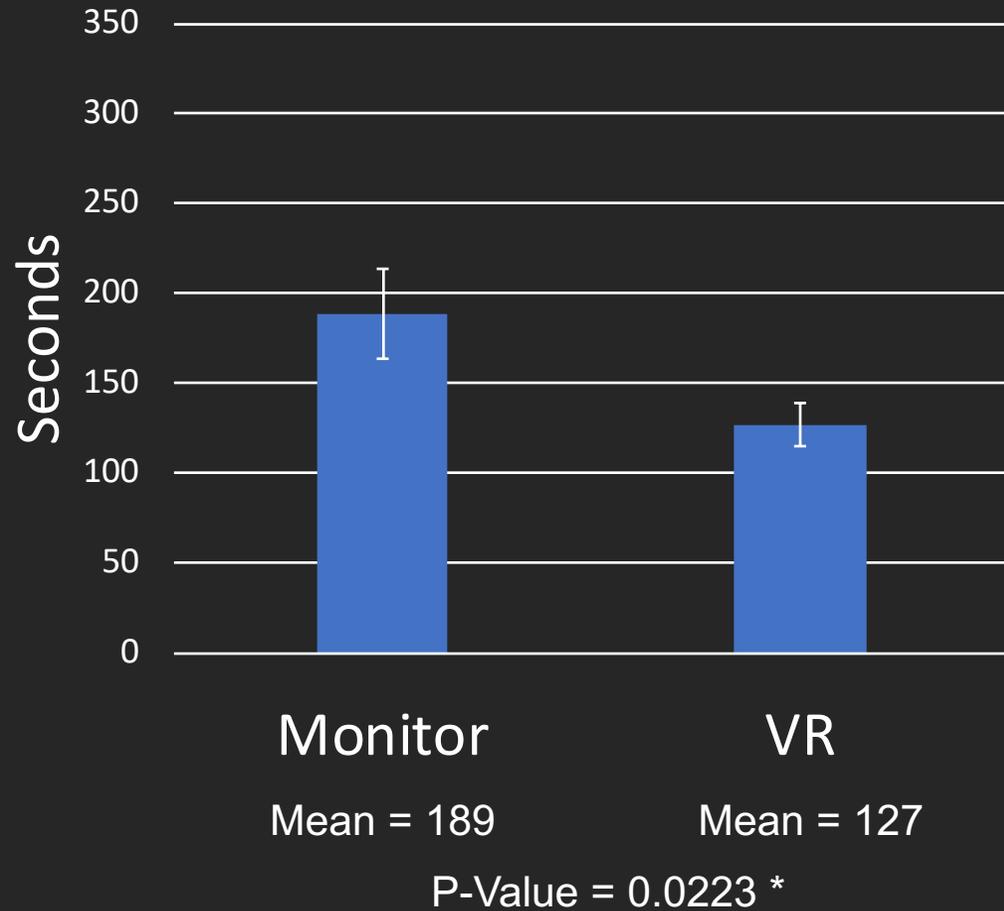


Experiment Task: Object Sorting

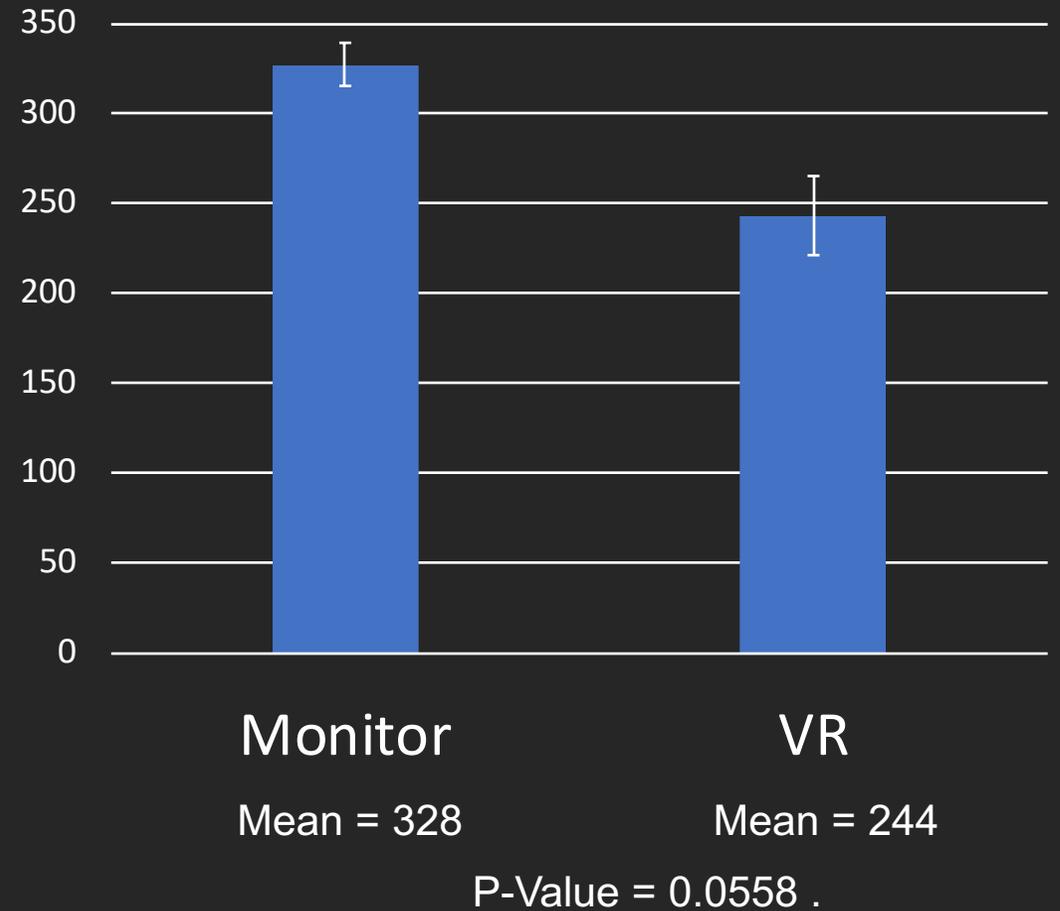


Stacking: Time to Complete

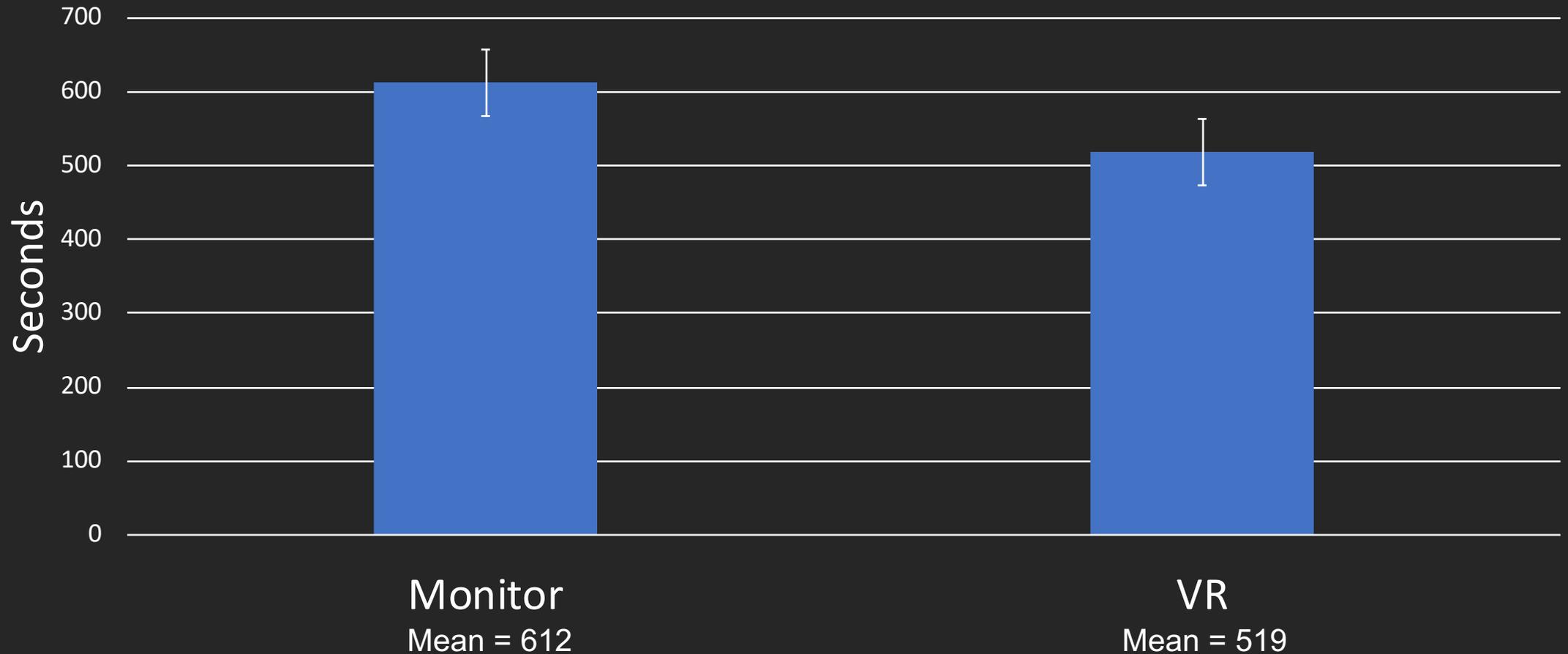
Cubes



Cylinders

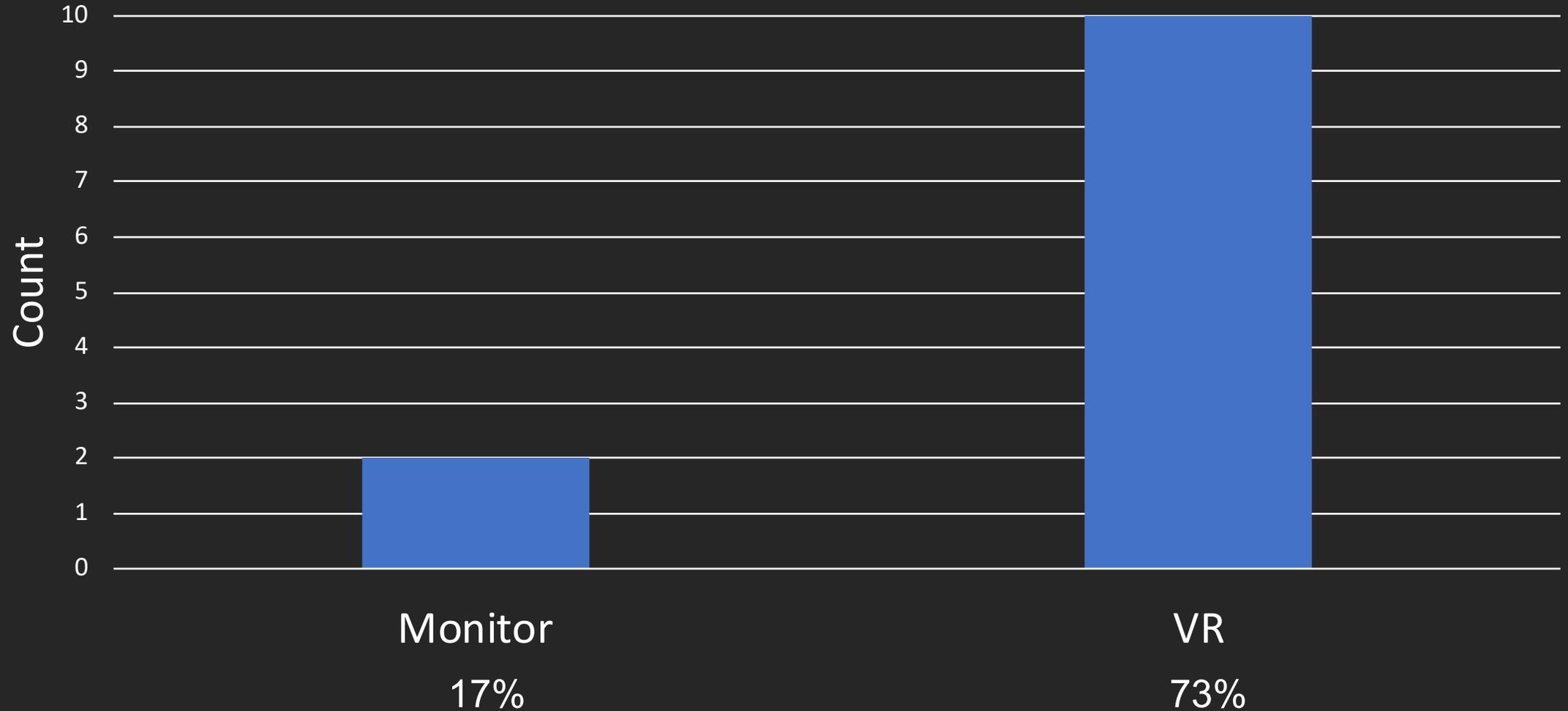


Sorting: Time to Complete



P-Value = 0.122

Overall Interface Preference



Follow Up Experiments

Explore more complex VR interfaces

Body Tracking

Head Tracking

Hand Tracking

Full-Body Tracking

Assistive Augmented Reality

Integration of Point Clouds



VR Telerobotics: Looking to the Future

Advance from VR Simulation to Teleoperation

Take Advantage of the Lunar Gateway

Prepare for Mars



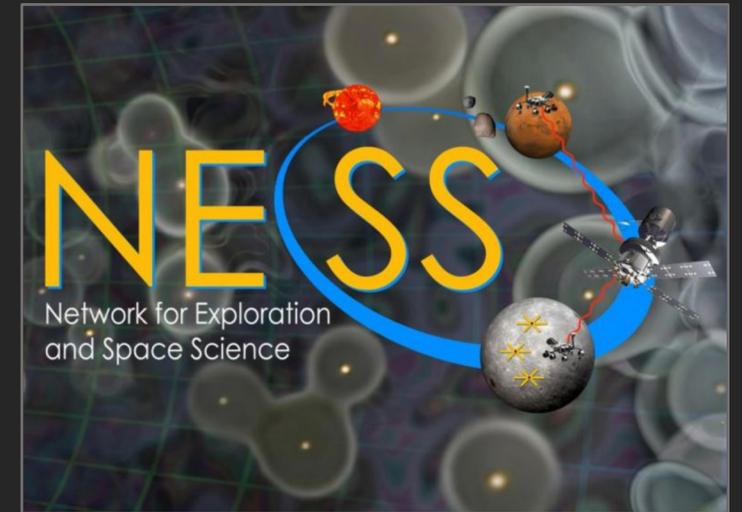
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Thank You!

Questions?



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VR Headsets and Robots

Stereoscopic 3D

Wide field-of-view

Immersion

Robot embodiment

User can “see” from the robot’s point-of-view



Experiment: Tasks & Format

Tasks

- 1.) Accuracy Drop
- 2.) Object Stacking
- 3.) Object Sorting

Format

Participant Training Session

Task 1: Randomized Condition One

Task 1: Randomized Condition Two

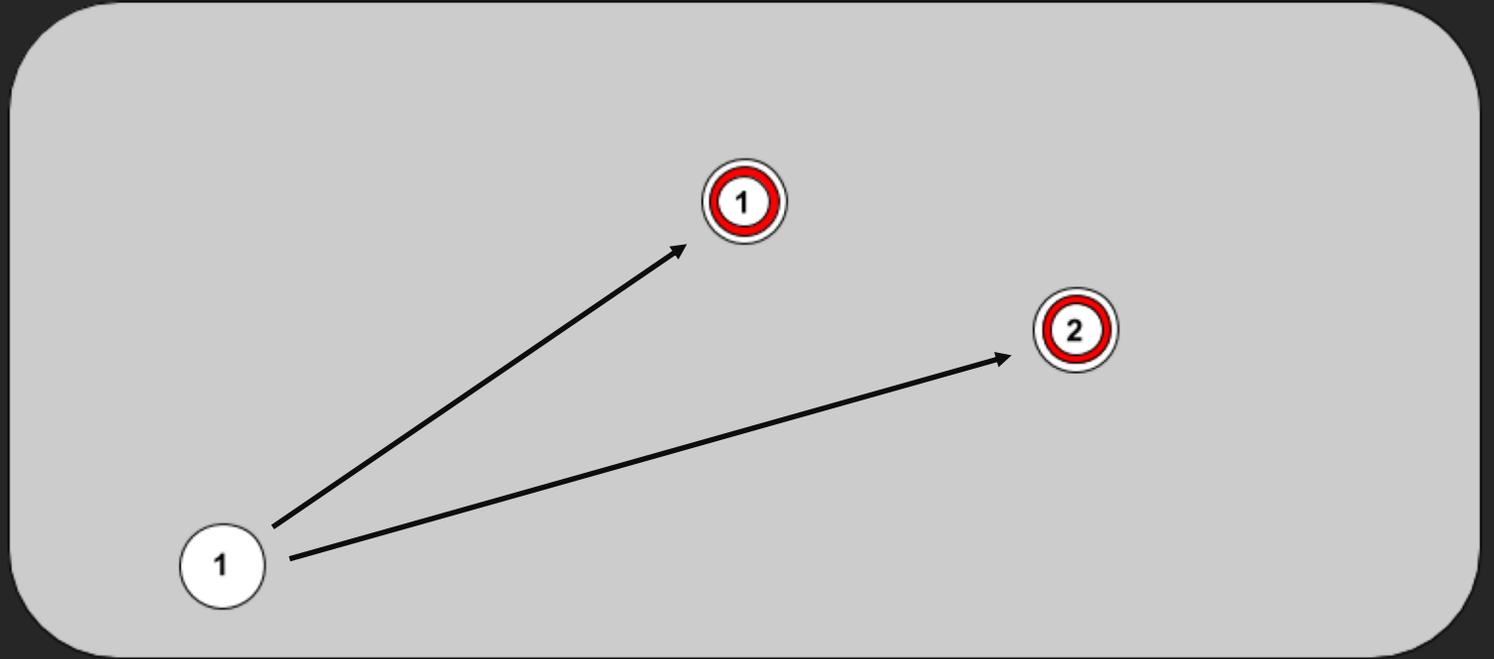
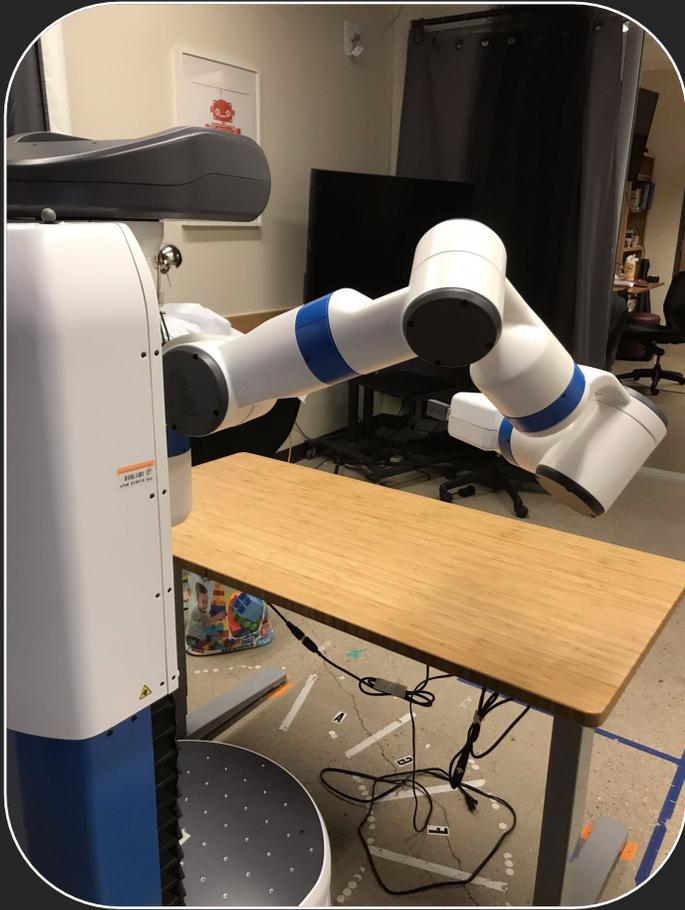
Task 2: Randomized Condition One

Task 2: Randomized Condition Two

Task 3: Randomized Condition One

Task 3: Randomized Condition Two

Experiment Task One: Accuracy Drop

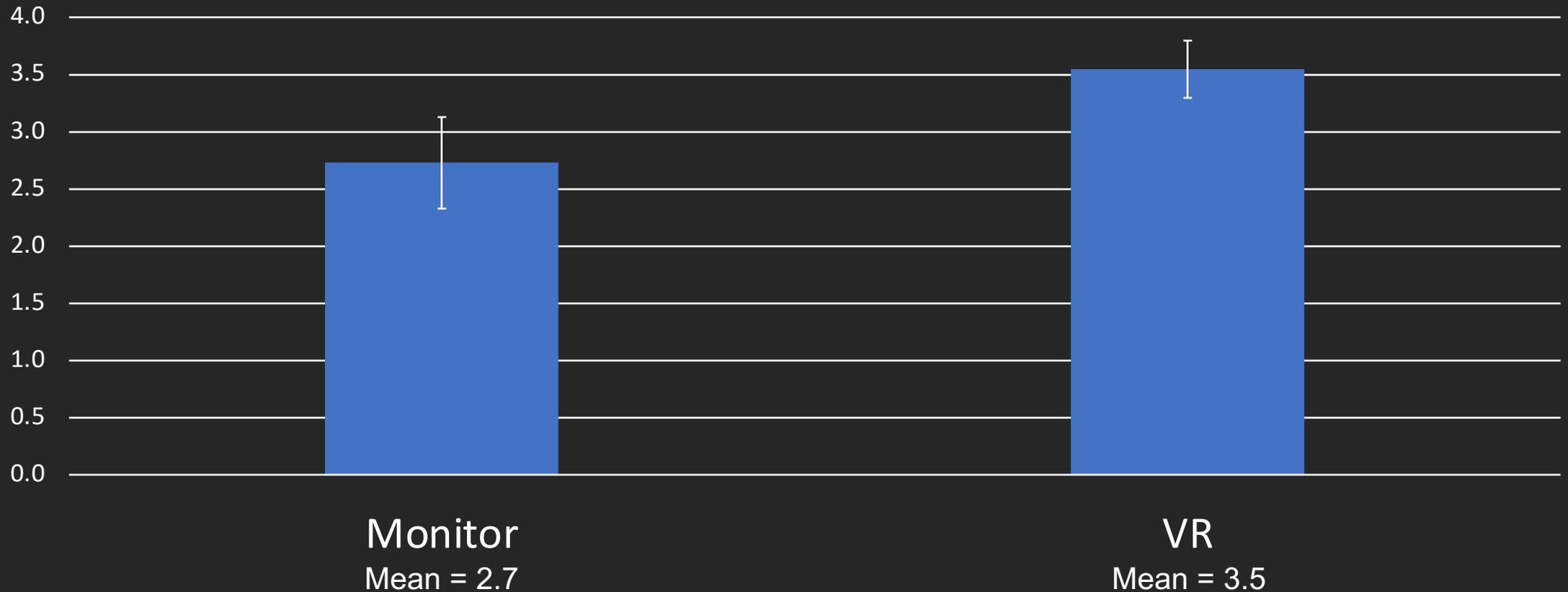


Drop 1: White 1 to Red 1
Drop 2: White 1 to Red 2



Stacking: Number of Objects Placed

Cylinders



P-Value = 0.0499 *

